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Research Article

Two new species of *Perenniporia* sensu lato (Polyporales, Basidiomycota) from China and two new combinations in *Crassisporus*

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Abstract

Phylogenetic and morphological analyses on *Perenniporia* s.l. were carried out. Phylogenies on *Perenniporia* s.l. are reconstructed with two loci DNA sequences including the internal transcribed spacer (ITS) regions and the large subunit (nLSU). Two new species from Yunnan Province, southwest China, *Perenniporia prunicola* and *P. rosicola* in *Perenniporia* s.l., are illustrated and described. *Perenniporia prunicola* is characterised by the perennial and resupinate basidiomata with a clay pink pore surface when fresh, a trimitic hyphal system, the presence of clavate to fusiform hymenial cystidia, ellipsoid to broadly ellipsoid basidiospores measuring 4.8–6.2 × 3.6–4.5 µm. *Perenniporia rosicola* is characterised by annual and resupinate basidiomata with a white pore surface when fresh, a dimitic hyphal system, the presence of dendrohyphidia, broadly ellipsoid to subglobose basidiospores measuring 5–5.8 × 4–5.2 µm. In addition, *Crassisporus* is a genus in *Perenniporia* s.l., in which two new combinations *Crassisporus minutus* and *C. mollissimus* are proposed. Main morphological characteristics of species related to new taxa are also provided.

Key words: Phylogeny, polypore, taxonomy, wood-decaying fungi

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Introduction

Perenniporia Murrill (Polyporales, Basidiomycetes) is typified by *P. medulla-panis* (Jacq.) Donk and it is one of the species-rich genera of Polyporales. Traditionally, it is characterised by annual to perennial, resupinate, effused-reflexed to pileate basidiomata with a varied coloured pore surface when fresh, a dimitic to trimitic hyphal system with generative hyphae bearing clamp connections, variably dextrinoid and cyanophilous skeletal hyphae, ellipsoid, broadly ellipsoid to subglobose, mostly thick-walled and truncate variably dextrinoid, cyano-

philous basidiospores and causing a white rot in dead angiosperm and gymnosperm woods (Ryvarden and Gilbertson 1994; Decock and Ryvarden 1999; Zhao et al. 2013a; Cui et al. 2019; Ji et al. 2023).

Perenniporia was established by Murrill in 1942 just with two species, *P. unita* (Pers.) Murrill (Basionym: *Polyporus unitus* Pers.) and *P. nigrescens* (Bres.) Murrill (Basionym: *Poria nigrescens* Bres.), none of which was regarded as the type species (Murrill 1942). Then *P. unita* was combined into different genera by other mycologists, viz. *Fibuloporia unita* (Pers.) Bondartsev, *Fomes unitus* (Pers.) J. Lowe and *Fomitopsis unita* (Pers.) Bondartsev (Bondartsev 1953; Lowe 1955), as well as being designated the lectotype of *Perenniporia* by Cooke (1953). Decock and Stalpers (2006) re-discussed the relationship and status of *Polyporus unitus* and *Boletus medulla-panis* Jacq., though they are synonymous and the latter has been normally regarded as the type species of *Perenniporia* in previous studies (Donk 1960; Ryvarden 1972a; Gilbertson and Ryvarden 1987; Ryvarden and Gilbertson 1994). In addition, they demonstrated *Pol. unitus* is not a synonym of *B. medulla-panis*, the latter of which was selected as the type of *Perenniporia* (Decock and Stalpers 2006). For now, *Poria nigrescens* as a synonym of *Physisporinus crocatus* (Pat.) F. Wu, Jia J. Chen & Y.C. Dai was described from Hungary and it has a perennial basidiomata, erubescent pores (white when fresh, then "carneo-violaceis", finally black), but no basidiospores data (Bresadola 1897).

Previous studies have shown that *Perenniporia* is a polyphyletic genus (Zhao et al. 2013a; Cui et al. 2019; Ji et al. 2023). Species in *Perenniporia* s.l. form seven independent clades, based on phylogenetic analysis with typical characteristics (Zhao et al. 2013a). *Hornodermoporus*, *Perenniporiella*, *Truncospora*, *Vanderbylia* etc. were derived from *Perenniporia* s.l. Especially, Ji et al. (2023) proposed 15 new genera previously addressed in *Perenniporia* s.l., based on phylogenetic and morphological analyses. *Perenniporia* s.s. contains three species, viz. *P. hainaniana* B.K. Cui & C.L. Zhao, *P. medulla-panis* and *P. substraminea* B.K. Cui & C.L. Zhao (Ji et al. 2023). Up to now, more than 120 taxa were found in *Perenniporia* s. l. (Ji et al. 2017; Liu et al. 2017; Shen et al. 2018; Cui et al. 2019; Zhao and Ma 2019; Ji et al. 2023). In addition, some species in *Perenniporia* s.l. could produce laccase (such as *P. tephropora* (Mont.) Ryvarden and *Poriella subacida* (Peck) C.L. Zhao) and carotenoid (such as *Vanderbylia fraxinea* (Bull.) D.A. Reid) etc. applied in both biomedical engineering and biodegradation (Si et al. 2011; Churapa and Lerluck 2016; Kim and Lee 2020).

Crassisporus B.K. Cui & Xing Ji was proposed as a new genus (Ji et al. 2019) and it has effused-reflexed to pileate basidiomata with a mostly concentrically zonate pileal surface, a trimitic hyphal system with inamyloid or non-dextrinoid skeletal hyphae, oblong to broadly ellipsoid, slightly thick-walled basidiospores (Ji et al. 2019). Four species are included in this genus currently.

During the fungal research work on polypores, the phylogeny, based on a two loci dataset (ITS+nLSU), was carried out and two unknown species of *Perenniporia* s.l. are found from southwest China and they are illustrated and described in the present paper. In addition, two new combinations in *Crassisporus* are proposed, based on phylogenetic and morphological analyses.

Materials and methods

Morphological studies

The studied specimens are deposited in the Fungarium of the Institute of Microbiology, Beijing Forestry University (BJFC) and the Institute of Applied Ecology, Chinese Academy of Sciences (IFP). Morphological descriptions are based on field notes and voucher specimens. The microscopic analysis follows Miettinen et al. (2018) and Wu et al. (2022). Sections were studied at a magnification of up to 1000× using a Nikon Eclipse 80i microscope and phase contrast illumination. Microscopic features and measurements were made from slide preparations stained with Cotton Blue and Melzer's reagent. Basidiospores were measured from sections cut from the tubes. To represent the variation in the size of spores, 5% of measurements were excluded from each end of the range and are given in parentheses. In the description: KOH = 5% potassium hydroxide, IKI = Melzer's reagent, IKI+ = amyloid or dextrinoid, IKI– = neither amyloid nor dextrinoid, CB = Cotton Blue, CB+ = cyanophilous in Cotton Blue, CB– = acyanophilous in Cotton Blue, L = arithmetic average of spore length, W = arithmetic average of spore width, Q = L/W ratios and n = number of basidiospores/measured from given number of specimens. Colour terms follow Anonymous (1969) and Petersen (1996).

DNA extraction, amplification and sequencing

A CTAB rapid plant genome extraction kit-DN14 (Aidlab Biotechnologies Co., Ltd, Beijing) was used to obtain DNA from dried specimens and to perform the polymerase chain reaction (PCR) according to the manufacturer's instructions with some modifications (Shen et al. 2019; Sun et al. 2020). The internal transcribed spacer (ITS) and large subunit nuclear ribosomal RNA gene (nLSU) were amplified using the primer pairs ITS5/ITS4 and LR0R/LR7 (White et al. 1990; Hopple and Vilgalys 1999) (https://sites.duke.edu/vilgalyslab/rdna_primers_for_fungi/).

The PCR procedure for ITS was as follows: initial denaturation at 95 °C for 3 min, followed by 34 cycles at 94 °C for 40 s, annealing at 54 °C for 45 s and extension 72 °C for 1 min and a final extension of 72 °C for 10 min. The PCR procedure for nLSU was as follows: initial denaturation at 94 °C for 1 min, followed by 34 cycles of denaturation at 94 °C for 30 s, annealing at 50 °C for 1 min and extension at 72 °C for 1.5 min and a final extension at 72 °C for 10 min. The PCR products were purified and sequenced at the Beijing Genomics Institute (BGI), China, with the same primers. DNA sequencing was performed at the Beijing Genomics Institute and the newly-generated sequences were deposited in GenBank. All sequences analysed in this study are listed in Table 1. Sequences generated from this study were aligned with additional sequences downloaded from GenBank using BioEdit (Hall 1999) and ClustalX (Thompson et al. 1997). The final ITS and nLSU datasets were subsequently aligned using MAFFT v.7 under the E-INS-i strategy with no cost for opening gaps and equal cost for transformations (command line: mafft –genafpair –maxiterate 1000) (Katoh and Standley 2013) and visualised in BioEdit (Hall 1999). Alignments were spliced and transformed formats in Mesquite v.3.2. (Maddison and Maddison 2017). Multiple se-

Table 1. Information for the sequences used in this study.

Species name	Sample no.	Location	GenBank accession No.		References
			ITS	nLSU	
Abundisporus fuscopurpureus	Cui 8638	China	JN048771	JN048790	Zhao et al. (2015)
Abundisporus pubertatis	Dai 11927	China	KC787569	KC787576	Zhao et al. (2015)
Abundisporus pubertatis	Dai 12140	China	JN048772	JN048791	Zhao et al. (2015)
Abundisporus sclerosetosus	MUCL 41438	Singapore	FJ411101	FJ393868	Robledo et al. (2009)
Abundisporus violaceus	MUCL 38617	Zimbabwe	FJ411100	FJ393867	Robledo et al. (2009)
Amylosporia hattorii	Cui 10912	China	KX900675	KX900725	Cui et al. (2019)
Amylosporia hattorii	Dai 10315	China	JQ861740	JQ861756	Cui et al. (2019)
Aurantioporia aurantiaca	CBS 125867	French Guiana	MH863779	MH875242	Vu et al. (2019)
Aurantioporia bambusicola	Cui 11050	China	KX900668	KX900719	Cui et al. (2019)
Citrinoporia citrinoalba	Cui 13615	China	MG847215	MG847224	Cui et al. (2019)
Citrinoporia citrinoalba	Dai 13643	China	KX880622	KX880661	Cui et al. (2019)
Citrinoporia corticola	Dai 18633	Malaysia	MT117217	MT117222	Wang et al. (2020)
Citrinoporia corticola	Dai 18641	Malaysia	MT117218	MT117223	Wang et al. (2020)
Citrinoporia corticola	Dai 17778	Singapore	MT117219	MT117224	Wang et al. (2020)
Citrinoporia corticola	Dai 18526	Malaysia	MT117216	MT117221	Wang et al. (2020)
Crassisporus imbricatus	Dai 10788	China	KC867350	KC867425	Cui et al. (2019)
Crassisporus leucoporus	Cui 16801	Australia	MK116488	MK116497	Ji et al. (2019)
Crassisporus macroporus	Cui 14468	China	MK116486	MK116495	Ji et al. (2019)
Crassisporus microsporus	Dai 16221	China	MK116487	MK116496	Ji et al. (2019)
Crassisporus minutus	Zhou 120	China	JX163055	JX163056	Unpublished
Crassisporus minutus	Cui 6595	China	KX081079	KX081142	Unpublished
Crassisporus minutus	Dai 22571	China	PP034100[a]	PP034116[a]	Present study
Crassisporus mollissimus	Cui 6257	China	JX141451	JX141461	Zhao et al. (2015)
Crassisporus mollissimus	Dai 10764	China	JX141452	JX141462	Zhao et al. (2015)
Cystidioporia piceicola	Cui 10460	China	JQ861742	JQ861758	Zhao and Cui (2013a)
Cystidioporia piceicola	Dai 4181	China	JF706328	JF706336	Cui and Zhao (2012)
Daedalea quercina	Dai 12659	Finland	KP171208	KP171230	Han et al. (2015)
Dendroporia cinereofusca	Dai 9289	China	KF568893	KF568895	Zhao et al. (2014b)
Dendroporia cinereofusca	Cui 5280	China	KF568892	KF568894	Zhao et al. (2014b)
Fomitopsis pinicola	Cui 10405	China	KC844852	KC844857	Unpublished
Hornodermoporus latissima	Cui 6625	China	HQ876604	HQ876604	Zhao et al. (2014a)
Hornodermoporus latissimus	Dai 12054	China	KX900639	KX900686	Cui et al. (2019)
Hornodermoporus martius	MUCL 41677	Argentina	FJ411092	FJ393859	Robledo et al. (2009)
Hornodermoporus martius	MUCL 41678	Argentina	FJ411093	FJ393860	Robledo et al. (2009)
Hornodermoporus martius	Cui 7992	China	HQ876603	HQ654114	Zhao et al. (2014a)
Luteoperenniporia australiensis	Cui 16742	Australia	OK642220	OK642275	Ji et al. (2023)
Luteoperenniporia australiensis	Cui 16743	Australia	OK642221	OK642276	Ji et al. (2023)
Luteoperenniporia bannaensis	Cui 8560	China	JQ291727	JQ291729	Zhao and Cui (2013a)
Luteoperenniporia bannaensis	Cui 8562	China	JQ291728	JQ291730	Zhao and Cui (2013a)
Luteoperenniporia mopanshanensis	CLZhao 5145	China	MH784912	MH784916	Zhao and Ma (2019)
Luteoperenniporia mopanshanensis	CL Zhao 5152	China	MH784913	MH784917	Zhao and Ma (2019)
Luteoperenniporia yinggelingensis	Cui 13625	China	MH427960	MH427967	Cui et al. (2019)
Luteoperenniporia yinggelingensis	Cui 13627	China	MH427957	MH427965	Cui et al. (2019)
Macroporia lacerata	Cui 7220	China	JX141448	JX141458	Zhao and Cui (2013a)
Macroporia lacerata	Dai 11268	China	JX141449	JX141459	Zhao and Cui (2013a)
Macroporia macropora	Zhou 280	China	JQ861748	JQ861764	Zhao and Cui (2013a)
Macroporia subrhizomorpha	LWZ 20190722-36	China	MZ578440	MZ578444	Tian et al. (2021)
Macrosporia nanlingensis	Cui 7620	China	HQ848477	HQ848486	Zhao and Cui (2013a)

Species name	Sample no.	Location	GenBank accession No.		References
			ITS	nLSU	
Macrosporia nanlingensis	Cui 7541	China	HQ848479	HQ848488	Zhao and Cui (2013a)
Microporellus subadustus	Cui 8459	China	HQ876606	HQ654113	Ji et al. (2023)
Microporellus violaceo-cinerascens	MUCL 45229	Ethiopia	FJ411106	FJ393874	Robledo et al. (2009)
Minoporus minor	Cui 5782	China	HQ883475	–	Zhao and Cui (2013a)
Minoporus minor	Dai 9198	China	KF495005	KF495016	Cui et al. (2019)
Neoporia bostonensis	CLZhao 2854	USA	MG491284	MG491287	Shen et al. (2018)
Neoporia bostonensis	CL Zhao 2855	USA	MG491285	MG491285	Shen et al. (2018)
Neoporia koreana	KUC20091030-32	Korea	KJ156313	KJ156305	Jang et al. (2015)
Neoporia koreana	KUC20081002J-02	Korea	KJ156310	KJ156302	Jang et al. (2015)
Neoporia rhizomorpha	Cui 7507	China	HQ654107	HQ654117	Zhao and Cui (2013a)
Neoporia rhizomorpha	Dai 7248	China	JF706330	JF706348	Zhao and Cui (2013a)
Niveoporia decurrata	Dai 16637	Thailand	KY475566	OP289291	Ji et al. (2017)
Niveoporia decurrata	Dai 16660	Thailand	KY475567	OP289292	Ji et al. (2017)
Niveoporia russeimarginata	Yuan 1244	China	JQ861750	JQ861766	Zhao and Cui (2013a)
Niveoporia subrusseimarginata	Cui 16991	China	OK642224	OK642279	Ji et al. (2023)
Niveoporia subrusseimarginata	Cui 16980	China	OK642223	OK642278	Ji et al. (2023)
Perenniporia cf. *dendrohyphidia*	Zhou 273	China	KX900670	–	Cui et al. (2019)
Perenniporia eugeissonae	Dai 18600	Malaysia	MT232518	MT232512	Wang et al. (2020)
Perenniporia eugeissonae	Dai 18605	Malaysia	MT232519	MT232513	Wang et al. (2020)
Perenniporia hainaniana	Cui 6366	China	JQ861745	JQ861761	Zhao and Cui (2013a)
Perenniporia hainaniana	Cui 6365	China	JQ861744	JQ861760	Zhao and Cui (2013a)
Perenniporia luteola	Harkonen 1308a	China	JX141456	JX141466	Zhao and Cui (2013b)
Perenniporia luteola	Harkonen 1308b	China	JX141457	JX141467	Zhao and Cui (2013b)
Perenniporia medulla-panis	Cui 3274	China	JN112792	JN112793	Zhao et al. (2014a)
Perenniporia medulla-panis	MUCL 43250	Norway	FJ411087	FJ393875	Robledo et al. (2009)
Perenniporia nonggangensis	GXU 2098	China	KT894732	KT894733	Huang et al. (2017)
Perenniporia nonggangensis	Dai 17857	Singapore	MT232521	MT232515	Huang et al. (2017)
Perenniporia prunicola	Dai 24280	China	PP034101[a]	PP034117[a]	Present study
Perenniporia prunicola	Dai 24751	China	PP034102[a]	PP034118[a]	Present study
Perenniporia prunicola	Dai 24752	China	PP034103[a]	–	Present study
Perenniporia pseudotephropora	Dai 17383	Brazil	MT117215	MT117220	Wang et al. (2020)
Perenniporia rosicola	Dai 22563	China	PP034110[a]	PP034123[a]	Present study
Perenniporia straminea	Cui 8858	China	HQ654104	JF706334	Zhao and Cui (2013a)
Perenniporia straminea	Cui 8718	China	HQ876600	HQ876600	Zhao and Cui (2013a)
Perenniporia substraminea	Cui 10191	China	JQ001853	JQ001845	Zhao et al. (2014a)
Perenniporia substraminea	Cui 10177	China	JQ001852	JQ001844	Zhao et al. (2014a)
Perenniporia subtephropora	Dai 10962	China	JQ861752	JQ861768	Zhao and Cui (2013a)
Perenniporia subtephropora	Dai 24890	China	PP034104[a]	PP034119[a]	Present study
Perenniporia subtephropora	Dai 25025	China	PP034105[a]	PP034120[a]	Present study
Perenniporia subtephropora	Dai 24871	China	PP034106[a]	–	Present study
Perenniporia subtephropora	Dai 10964	China	JQ861753	JQ861769	Zhao and Cui (2013a)
Perenniporia subtephropora	Dai 24877	China	PP034107[a]	PP034121[a]	Present study
Perenniporia tephropora	Cui 9029	China	HQ876601	JF706339	Zhao and Cui (2013a)
Perenniporia tephropora	Cui 6331	China	HQ848473	HQ848484	Zhao and Cui (2013a)
Perenniporia tephropora	Dai 25106	China	PP034108[a]	–	Present study
Perenniporia tephropora	Dai 24849	China	PP034109[a]	PP034122[a]	Present study
Perenniporiella chaquenia	MUCL 47647	Argentina	FJ411083	FJ393855	Robledo et al. (2009)
Perenniporiella chaquenia	MUCL 47648	Argentina	FJ411084	FJ393856	Robledo et al. (2009)
Perenniporiella micropora	MUCL 43581	Cuba	FJ411086	FJ393858	Robledo et al. (2009)
Perenniporiopsis minutissima	Cui 10979	China	KF495003	KF495013	Cui et al. (2019)
Perenniporiopsis minutissima	Dai 12457	China	KF495004	KF495014	Cui et al. (2019)
Perenniporiopsis minutissima	Dai 17383	Brazil	MT117215	MT117220	Wang et al. (2020)
Perenniporiopsis minutissima	Dai 24887	China	PP034111[a]	–	Present study

Species name	Sample no.	Location	GenBank accession No.		References
			ITS	nLSU	
Perenniporiopsis minutissima	Dai 24885	China	PP034112[a]	–	Present study
Perenniporiopsis minutissima	Cui 10221	China	KX962546	KX962553	Wu et al. (2017)
Perenniporiopsis sinensis	Dai 26477	China	PP034113[a]	PP034124[a]	Present study
Perenniporiopsis sinensis	CLZhao 8278	China	OR149913	OR759768	Yang et al. (2024)
Poriella africana	Cui 8674	China	KF018119	KF018128	Zhao et al. (2015)
Poriella africana	Cui 8676	China	KF018120	KF018129	Zhao et al. (2015)
Poriella ellipsospora	Cui 10284	China	JQ861739	KF018133	Shen et al. (2018)
Poriella ellipsospora	Cui 10276	China	KF018124	KF018132	Shen et al. (2018)
Poriella subacida	Dai 8224	China	HQ876605	JF713024	Zhao and Cui (2013a)
Poriella valliculorum	LE 222974	Russia	KM411458	KM411474	Zmitrovich and Kovalenko (2016)
Poriella valliculorum	Cui 10053	China	KF495006	KF495017	Zhao et al. (2014a)
Rhizoperenniporia japonica	Cui 7047	China	KX900677	KX900727	Cui et al. (2019)
Sparsitubus nelumbiformis	Cui 6590	China	KX880632	KX880671	Cui et al. (2019)
Sparsitubus nelumbiformis	Cui 8497	China	KX880631	KX880670	Cui et al. (2019)
Tropicoporia aridula	Dai 12398	China	JQ001855	JQ001847	Zhao and Cui (2013a)
Tropicoporia aridula	Dai 12396	China	JQ001854	JQ001846	Zhao and Cui (2013a)
Truncatoporia pyricola	Cui 9149	China	JN048762	JN048782	Zhao and Cui (2013a)
Truncatoporia pyricola	Dai 10265	China	JN048761	JN048781	Zhao and Cui (2013a)
Truncatoporia truncatospora	Cui 6987	China	JN048778	HQ654112	Zhao and Cui (2013a)
Truncatoporia truncatospora	Dai 5125	China	HQ654098	HQ848481	Zhao and Cui (2013a)
Truncospora detrita	MUCL 42649	French Guiana	FJ411099	FJ411099	Robledo et al. (2009)
Truncospora macrospora	Cui 8106	China	JX941573	JX941596	Zhao and Cui (2013c)
Truncospora ochroleuca	MUCL 39726	China	FJ411098	FJ393865	Robledo et al. (2009)
Truncospora ochroleuca	Dai 11486	China	HQ654105	JF706349	Zhao and Cui (2012)
Truncospora ochroleuca	MUCL 39563	Australia	FJ411097	FJ393864	Robledo et al. (2009)
Truncospora ohiensis	Cui 5714	China	HQ654103	HQ654116	Cui and Zhao (2012)
Truncospora ohiensis	MUCL 41036	USA	FJ411096	FJ393863	Robledo et al. (2009)
Truncospora ornata	SP 6672	Russia	KJ410690	–	Spirin et al. (2015)
Vanderbylia delavayi	Dai 6891	China	JQ861738	–	Zhao et al. (2014a)
Vanderbylia fraxinea	Cui 8871	China	JF706329	JF706345	Zhao et al. (2014a)
Vanderbylia fraxinea	Cui 8885	China	HQ876611	JF706344	Zhao et al. (2014a)
Vanderbylia fraxinea	DP 83	Italy	AM269789	AM269853	Guglielmo et al. (2007)
Vanderbylia robiniophila	Cui 7144	China	HQ876608	JF706341	Zhao et al. (2014a)
Vanderbylia robiniophila	Cui 5644	China	HQ876609	HQ876609	Zhao and Cui (2013a)
Vanderbylia vicina	MUCL 44779	Ethiopia	FJ411095	FJ393862	Robledo et al. (2009)
Vanderbyliella sp.	Knudsen 04-111	China	JQ861737	JQ861755	Zhao and Cui (2013a)
Vanderbyliella tianmuensis	Cui 2715	China	JX141454	JX141464	Zhao and Cui (2013a)
Vanderbyliella tianmuensis	Cui 2648	China	JX141453	JX141463	Zhao and Cui (2013a)
Xanthoperenniporia maackiae	Dai 8929	China	HQ654102	JF706338	Zhao and Cui (2013a)
Xanthoperenniporia maackiae	Cui 5605	China	JN048760	JN048780	Zhao et al. (2013b)
Xanthoperenniporia punctata	Dai 26121	China	PP034114[a]	–	Present study
Xanthoperenniporia punctata	Dai 26120	China	PP034115[a]	–	Present study
Xanthoperenniporia punctata	Dai 17916	China	MG869686	MG869688	Li et al. (2018)
Xanthoperenniporia subcorticola	Dai 7330	China	HQ654094	HQ654108	Zhao and Cui (2013a)
Xanthoperenniporia subcorticola	Cui 1248	China	HQ848472	HQ848482	Zhao and Cui (2013a)
Xanthoperenniporia subcorticola	Cui 2655	China	HQ654093	HQ654093	Zhao and Cui (2012)
Xanthoperenniporia tenuis	Wei 2969	China	JQ001859	JQ001849	Zhao and Cui (2013a)
Xanthoperenniporia tenuis	Wei 2783	China	JQ001858	JQ001848	Zhao and Cui (2013a)
Yuchengia kilemariensis	LE 214743	Russia	KM411457	KM411473	Zmitrovich and Kovalenko (2016)
Yuchengia narymica	Dai 10510	China	HQ654101	JF706346	Zhao et al. (2013b)

[a] Newly-generated sequences in this study.
Bold = new taxa.

quence alignments were trimmed by trimAl v.1.2 using the -htmlout-gt 0.8 -st option to deal with gaps, when necessary (Capella-Gutierrez et al. 2009).

Phylogenetic analyses

In this study, one combined matrix was reconstructed for phylogenetic analyses; a two loci dataset (ITS+nLSU) was used to determine the phylogenetic position of the new species. The sequence alignments and the retrieved topologies were deposited in TreeBase (http://www.treebase.org), under accession ID: 31050 (Reviewer access URL: http://purl.org/phylo/treebase/phylows/study/TB2:S31050?x-access-code=fa4d2a2edcdd53d63276b66a95c2058d&format=html). Sequences of *Fomitopsis pinicola* (Sw.) P. Karst. and *Daedalea quercina* (L.) Pers., obtained from GenBank, were used as the outgroups (Ji et al. 2023). The phylogenetic analyses followed the approach of Han et al. (2016) and Zhu et al. (2019). Maximum Likelihood (ML) and Bayesian Inference (BI) analyses were performed, based on the two datasets. The best-fit evolutionary model was selected by Hierarchical Likelihood Ratio Tests (HLRT) and Akaike Information Criterion (AIC) in MrModelTest 2.2 (Nylander 2004) after scoring 24 models of evolution in PAUP* version 4.0b10 (Swofford 2002).

Sequences were analysed using Maximum Likelihood (ML) with RAxML-HPC2 through the CIPRES Science Gateway (www.phylo.org; Miller et al. 2010). Branch support (BT) for ML analysis was determined by 1000 bootstrap replicates. Bayesian phylogenetic inference and Bayesian Posterior Probabilities (BPP) were computed with MrBayes 3.1.2 (Ronquist and Huelsenbeck 2003). Four Markov chains were run for 5 M generations (two loci dataset) until the split deviation frequency value was less than 0.01 and trees were sampled every 100 generations. The first 25% of the sampled trees were discarded as burn-in and the remaining ones were used to reconstruct a majority rule consensus and calculate Bayesian Posterior Probabilities (BPP) of the clades. All trees were viewed in FigTree v. 1.4.3 (http://tree.bio.ed.ac.uk/software/figtree/). Branches that received bootstrap support for ML (≥ 75% (ML-BS)) and BPP (≥ 0.95 BPP) were considered as significantly supported. The ML bootstrap (ML) ≥ 50% and BBP (BPP) ≥ 0.90 are presented on topologies from ML analysis, respectively.

Results

Molecular phylogeny

The combined two loci dataset (ITS+nLSU) included sequences from 152 samples representing 80 taxa. The dataset had an aligned length of 2156 characters, of which 1385 (64%) characters were constant, 147 (7%) were variable and parsimony-uninformative and 624 (29%) were parsimony informative. The phylogenetic reconstruction performed with Maximum Likelihood (ML) and Bayesian Inference (BI) analyses for one combined dataset showed similar topology and few differences in statistical support. The best model-fit applied in the Bayesian analysis was GTR+I+G, lset nst = 6, rates = invgamma and prset statefreqpr = dirichlet (1, 1, 1, 1). Bayesian analysis resulted in a nearly congruent topology with an average standard deviation of split frequencies = 0.007133 to ML analysis and, thus, only the ML tree is provided (Fig. 1).

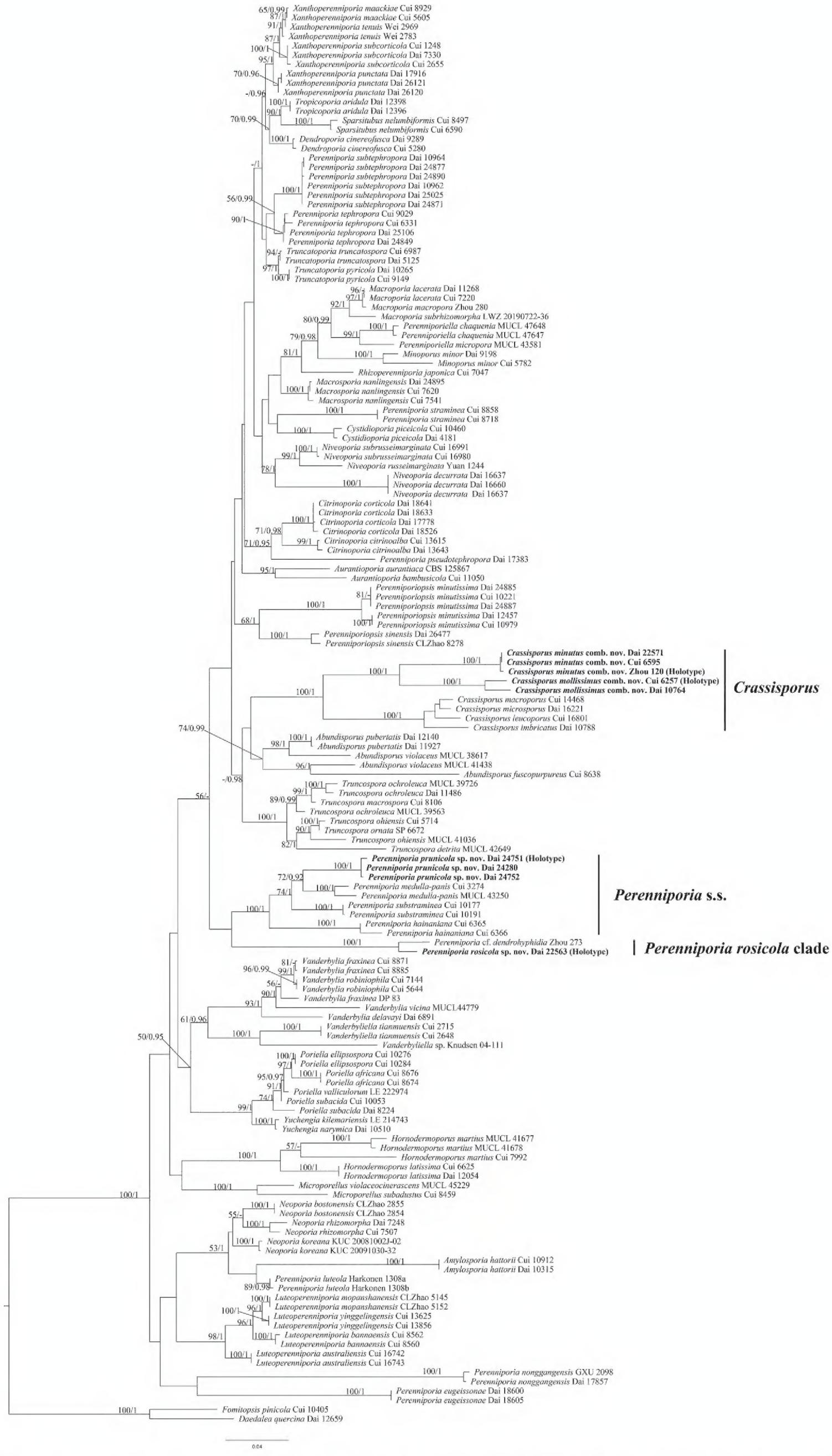

Xanthoperenniporia maackiae Cui 8929
Xanthoperenniporia maackiae Cui 5605
Xanthoperenniporia tenuis Wei 2969
Xanthoperenniporia tenuis Wei 2783
Xanthoperenniporia subcorticola Cui 1248
Xanthoperenniporia subcorticola Dai 7330
Xanthoperenniporia subcorticola Cui 2655
Xanthoperenniporia punctata Dai 17916
Xanthoperenniporia punctata Dai 26121
Xanthoperenniporia punctata Dai 26120
Tropicoporia aridula Dai 12398
Tropicoporia aridula Dai 12396
Sparsitubus nelumbiformis Cui 8497
Sparsitubus nelumbiformis Cui 6590
Dendroporia cinereofusca Dai 9289
Dendroporia cinereofusca Cui 5280
Perenniporia subtephropora Dai 10964
Perenniporia subtephropora Dai 24877
Perenniporia subtephropora Dai 24890
Perenniporia subtephropora Dai 10962
Perenniporia subtephropora Dai 25025
Perenniporia subtephropora Dai 24871
Perenniporia tephropora Cui 9029
Perenniporia tephropora Cui 6331
Perenniporia tephropora Dai 25106
Perenniporia tephropora Dai 24849
Truncatoporia truncatospora Cui 6987
Truncatoporia truncatospora Dai 5125
Truncatoporia pyricola Dai 10265
Truncatoporia pyricola Cui 9149
Macroporia lacerata Dai 11268
Macroporia lacerata Cui 7220
Macroporia macropora Zhou 280
Macroporia subrhizomorpha LWZ 20190722-36
Perenniporiella chaquenia MUCL 47648
Perenniporiella chaquenia MUCL 47647
Perenniporiella micropora MUCL 43581
Minoporus minor Dai 9198
Minoporus minor Cui 5782
Rhizoperenniporia japonica Cui 7047
Macrosporia nanlingensis Dai 24895
Macrosporia nanlingensis Cui 7620
Macrosporia nanlingensis Cui 7541
Perenniporia straminea Cui 8858
Perenniporia straminea Cui 8718
Cystidioporia piceicola Cui 10460
Cystidioporia piceicola Dai 4181
Niveoporia subrusseimarginata Cui 16991
Niveoporia subrusseimarginata Cui 16980
Niveoporia russeimarginata Yuan 1244
Niveoporia decurrata Dai 16637
Niveoporia decurrata Dai 16660
Niveoporia decurrata Dai 16637
Citrinoporia corticola Dai 18641
Citrinoporia corticola Dai 18633
Citrinoporia corticola Dai 17778
Citrinoporia corticola Dai 18526
Citrinoporia citrinoalba Cui 13615
Citrinoporia citrinoalba Dai 13643
Perenniporia pseudotephropora Dai 17383
Aurantioporia aurantiaca CBS 125867
Aurantioporia bambusicola Cui 11050
Perenniporiopsis minutissima Dai 24885
Perenniporiopsis minutissima Cui 10221
Perenniporiopsis minutissima Dai 24887
Perenniporiopsis minutissima Dai 12457
Perenniporiopsis minutissima Cui 10979
Perenniporiopsis sinensis Dai 26477
Perenniporiopsis sinensis CLZhao 8278
Crassisporus minutus comb. nov. Dai 22571
Crassisporus minutus comb. nov. Cui 6595
Crassisporus minutus comb. nov. Zhou 120 (Holotype)
Crassisporus mollissimus comb. nov. Cui 6257 (Holotype)
Crassisporus mollissimus comb. nov. Dai 10764
Crassisporus macroporus Cui 14468
Crassisporus microsporus Dai 16221
Crassisporus leucoporus Cui 16801
Crassisporus imbricatus Dai 10788
Abundisporus pubertatis Dai 12140
Abundisporus pubertatis Dai 11927
Abundisporus violaceus MUCL 38617
Abundisporus violaceus MUCL 41438
Abundisporus fuscopurpureus Cui 8638
Truncospora ochroleuca MUCL 39726
Truncospora ochroleuca Dai 11486
Truncospora macrospora Cui 8106
Truncospora ochroleuca MUCL 39563
Truncospora ohiensis Cui 5714
Truncospora ornata SP 6672
Truncospora ohiensis MUCL 41036
Truncospora detrita MUCL 42649
Perenniporia prunicola sp. nov. Dai 24751 (Holotype)
Perenniporia prunicola sp. nov. Dai 24280
Perenniporia prunicola sp. nov. Dai 24752
Perenniporia medulla-panis Cui 3274
Perenniporia medulla-panis MUCL 43250
Perenniporia substraminea Cui 10177
Perenniporia substraminea Cui 10191
Perenniporia hainaniana Cui 6365
Perenniporia hainaniana Cui 6366
Perenniporia cf. dendrohyphidia Zhou 273
Perenniporia rosicola sp. nov. Dai 22563 (Holotype)
Vanderbylia fraxinea Cui 8871
Vanderbylia fraxinea Cui 8885
Vanderbylia robiniophila Cui 7144
Vanderbylia robiniophila Cui 5644
Vanderbylia fraxinea DP 83
Vanderbylia vicina MUCL44779
Vanderbylia delavayi Dai 6891
Vanderbyliella tianmuensis Cui 2715
Vanderbyliella tianmuensis Cui 2648
Vanderbyliella sp. Knudsen 04-111
Poriella ellipsospora Cui 10276
Poriella ellipsospora Cui 10284
Poriella africana Cui 8676
Poriella africana Cui 8674
Poriella valliculorum LE 222974
Poriella subacida Cui 10053
Poriella subacida Dai 8224
Yuchengia kilemariensis LE 214743
Yuchengia narymica Dai 10510
Hornodermoporus martius MUCL 41677
Hornodermoporus martius MUCL 41678
Hornodermoporus martius Cui 7992
Hornodermoporus latissima Cui 6625
Hornodermoporus latissima Dai 12054
Microporellus violaceocinerascens MUCL 45229
Microporellus subadustus Cui 8459
Neoporia bostonensis CLZhao 2855
Neoporia bostonensis CLZhao 2854
Neoporia rhizomorpha Dai 7248
Neoporia rhizomorpha Cui 7507
Neoporia koreana KUC 20081002J-02
Neoporia koreana KUC 20091030-32
Amylosporia hattorii Cui 10912
Amylosporia hattorii Dai 10315
Perenniporia luteola Harkonen 1308a
Perenniporia luteola Harkonen 1308b
Luteoperenniporia mopanshanensis CLZhao 5145
Luteoperenniporia mopanshanensis CLZhao 5152
Luteoperenniporia yinggelingensis Cui 13625
Luteoperenniporia yinggelingensis Cui 13856
Luteoperenniporia bannaensis Cui 8562
Luteoperenniporia bannaensis Cui 8560
Luteoperenniporia australiensis Cui 16742
Luteoperenniporia australiensis Cui 16743
Perenniporia nonggangensis GXU 2098
Perenniporia nonggangensis Dai 17857
Perenniporia eugeissonae Dai 18600
Perenniporia eugeissonae Dai 18605
Fomitopsis pinicola Cui 10405
Daedalea quercina Dai 12659
Crassisporus
Perenniporia s.s.
Perenniporia rosicola clade
0.04

Figure 1. ML analysis of *Perenniporia* s.l. based on dataset of ITS+nLSU. ML bootstrap values higher than 50% and Bayesian posterior probabilities values more than 0.90 are shown. New taxa are in bold.

The phylogeny (Fig. 1) included 28 different genera in *Perenniporia* s.l., of which have eight uncertain species in regard to the generic status without typical characteristics, viz. *P. eugeissonae* P. Du & Chao G. Wang, *P. luteola* B.K. Cui & C.L. Zhao, *P. nonggangensis* F.C. Huang & Bin Liu, *P. pseudotephropora* Chao G. Wang & F. Wu, *P. rosicola*, *P. straminea* (Bres.) Ryvarden, *P. subtephropora* B.K. Cui & C.L. Zhao and *P. tephropora*. Thus, they were adopted in *Perenniporia* temporarily and distinguished from *Perenniporia* s.s.

Perenniporia prunicola nested in the *Perenniporis* s.s. clade and formed an independent lineage in the phylogeny (Fig. 1). In addition, it is related to *P. medulla-panis*, *P. substraminea* and *P. hainaniana*, these four species being addressed into the *Perenniporia* s.s. clade. Though *Perenniporia rosicola* grouped with four species of *Perenniporia* s.s. in a joint subclade, but without support. The sequences of *Crassisporus minutus* and *C. mollissimus* were obtained from holotypes and they nested in the genus *Crassisporus*.

ITS sequences produced significant alignments in NCBI (https://www.ncbi.nlm.nih.gov/) about *Perenniporia prunicola*, the top ten of which represent *P. medulla-panis* and the similarities of them were less than 95%. The same goes for *P. rosicola*, the similarities of the top ten ITS sequences in NCBI were less than 90% excepting one sequence tagged *P. dendrohyphidia* (Zhou 273). They are consistent with our phylogeny.

Taxonomy

***Perenniporia prunicola* Y.C. Dai, Yuan Yuan & Chao G. Wang, sp. nov.**

MycoBank No: 851532

Figs 2, 3

Holotype. China. Yunnan Province, Zhaotong, Yiliang County, Xiaocaoba Town, on living tree of *Prunus*, 2.IV.2023, Dai 24751 (BJFC040388).

Etymology. *Prunicola* (Lat.): refers to the species growing on *Prunus*.

Description. ***Basidiomata.*** Perennial, resupinate, corky, without odour or taste when fresh, becoming hard corky upon drying, up to 15 cm long, 5 cm wide and 16 mm thick at centre. Pore surface clay pink when fresh, becoming cream, buff yellow to fawn upon drying; sterile margin very narrow to almost absent; pores round to slightly elongated, 4–6 per mm; dissepiments slightly thick, entire. Subiculum thin, cream, corky, up to 1 mm thick. Tubes pinkish-buff to clay buff when dry, distinctly stratified, hard corky, up to 15 mm long.

Hyphal structure. Hyphal system trimitic; generative hyphae bearing clamp connections; skeletal and binding hyphae IKI−, weakly CB+; tissues becoming orange brown in KOH.

Subiculum. Generative hyphae frequent, hyaline, thin-walled, occasionally branched, more or less flexuous, 2–4 µm in diam.; skeletal hyphae dominant, hyaline, thick-walled with a wide lumen, occasionally branched, more or less flexuous, 2.5–3 µm in diam.; binding hyphae hyaline, thick-walled with a wide lumen, frequently arboriform branched, flexuous, interwoven, 1.5–2 µm in diam.

Tubes. Generative hyphae infrequent, hyaline, thin-walled, occasionally branched, straight, 2–3 µm in diam.; skeletal hyphae dominant, hyaline, thick-walled with a medium lumen, occasionally branched, slightly flexuous, interwoven, 2–2.5 µm in diam.; binding hyphae hyaline, thick-walled with a medium

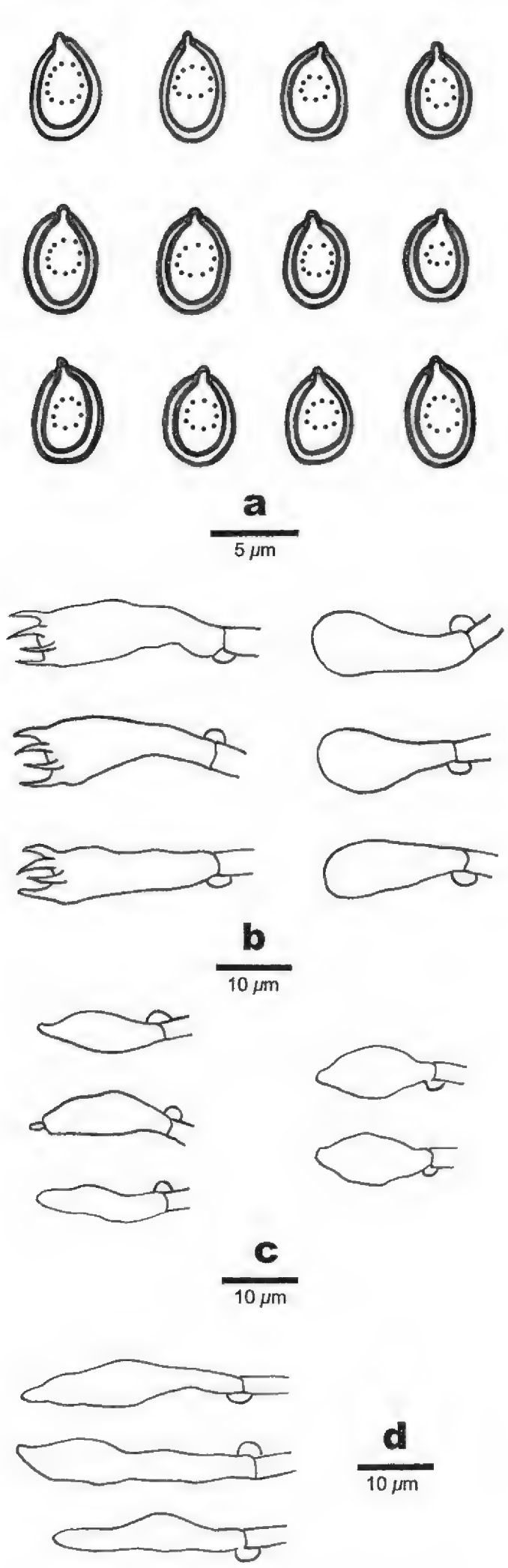
Figure 2. Basidiomata of *Perenniporia prunicola* (Holotype, Y.C. Dai 24751). Scale bar: 1 cm.

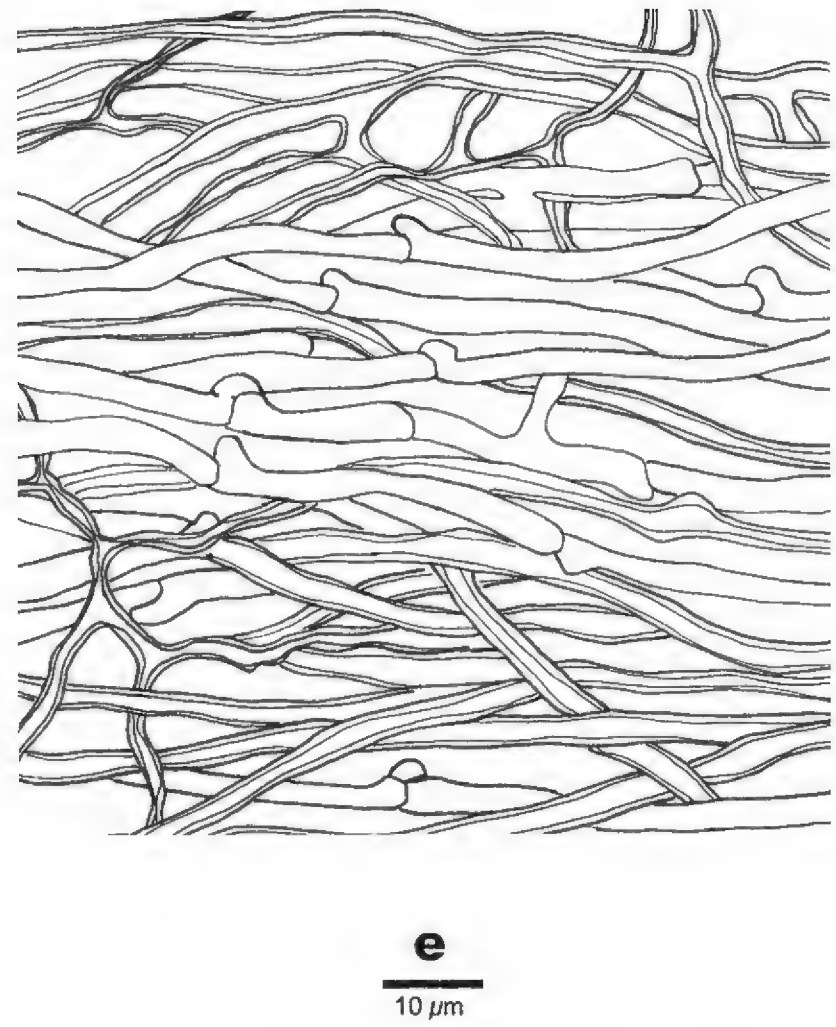
lumen, frequently arboriform branched, flexuous, interwoven, 1.2–1.5 µm in diam. Hymenial cystidia present, clavate to fusiform, thin-walled, smooth, 25–31 × 5–5.5 µm; cystidioles present, ventricose to fusiform, hyaline, thin-walled, 16–20 × 4.5–5 µm. Basidia clavate, with four sterigmata and a basal clamp connection, 15–22 × 7–8 µm; basidioles more or less pyriform, but smaller. Irregular crystals present among the hymenium.

Spores. Basidiospores ellipsoid to broadly ellipsoid, hyaline, thick-walled, smooth, usually with a medium guttule, dextrinoid, weakly CB+, (4.5–)4.8–6.2(–6.5) × (3.5–)3.6–4.5(–4.9) µm, L = 5.39 µm, W = 4.07 µm, Q = 1.29–1.37 (n = 90/3).

Type of rot. White rot.

Additional specimens examined. China. Guizhou Province, Zunyi, Suiyang County, Kuankuoshui Nature Reserve, on fallen trunk of *Prunus*, 7.VII.2022, Y.C.





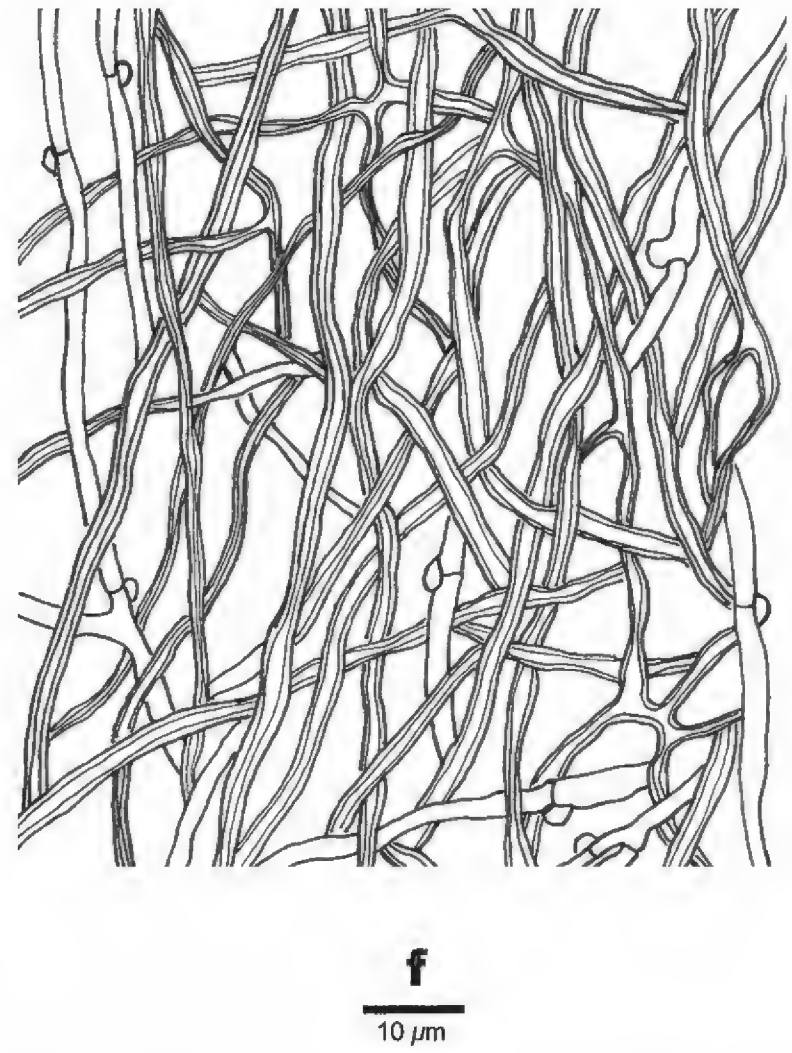


Figure 3. Microscopic structures of *Perenniporia prunicola* (Holotype, Y.C. Dai 24751) **a** basidiospores **b** basidia and basidioles **c** cystidioles **d** hymenial cystidia **e** hyphae from subiculum **f** hyphae from trama.

Dai 24280 (BJFC039522); Yunnan Province, Zhaotong, Yiliang County, Xiaocaoba, on dead tree of *Prunus*, 2.IV.2023, Y.C. Dai 24752 (BJFC040389).

Notes. *Perenniporia prunicola* is characterised by perennial and resupinate basidiomata with a clay pink pore surface when fresh, round to slightly elongated pores of 4–6 per mm, a trimitic hyphal system, the presence of clavate to fusiform hymenial cystidia, ellipsoid to broadly ellipsoid and thick-walled basidiospores measuring 4.8–6.2 × 3.6–4.5 μm and growth on *Prunus* in southwest China.

Perenniporia rosicola **Y.C. Dai, Yuan Yuan & Chao G. Wang, sp. nov.**
MycoBank No: 851529
Figs 4, 5

Holotype. China. Yunnan Province, Mengla County, Xishuangbanna Rainforest Valley, on branch of Rosaceae, 4.VII.2021, Y.C. Dai 22563 (BJFC037137).

Etymology. *Rosicola* (Lat.): refers to the species growing on Rosaceae.

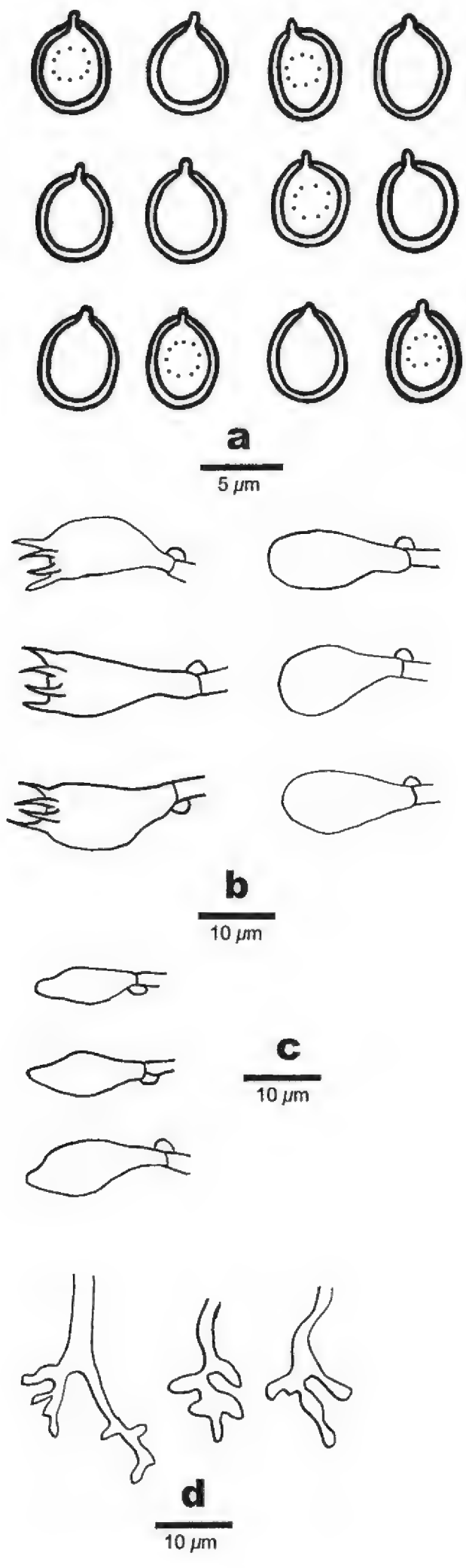
Description. ***Basidiomata.*** Annual, resupinate, soft corky, without odour or taste when fresh, becoming corky when dry, up to 2 cm long, 1.5 cm wide and 1.2 mm thick at centre. Pore surface white when fresh, becoming pale orange brown upon bruising, eventually honey yellow to clay buff upon drying; sterile margin white when fresh, becoming cream upon drying, up to 0.5 mm wide; pores round, sometimes elongated, 5–7 per mm; dissepiments thin, entire to slightly lacerate. Subiculum very thin, cream, corky, up to 0.2 mm thick. Tubes concolorous with pore surface, corky, up to 1 mm long.

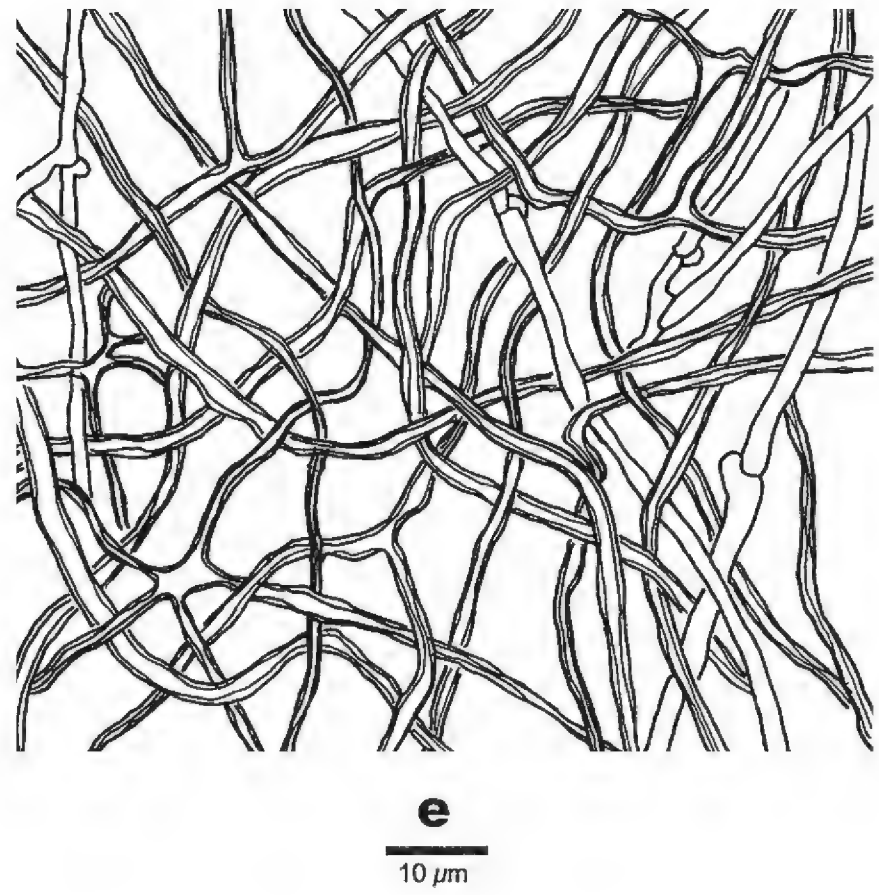
Hyphal structure. Hyphal system dimitic; generative hyphae bearing clamp connections; skeletal hyphae dextrinoid, weakly CB+; tissues becoming pale olivaceous in KOH.

Subiculum. Generative hyphae infrequent, hyaline, thin-walled, occasionally branched, straight, 2–2.5 µm in diam.; skeletal hyphae dominant, hyaline, thick-walled with a medium to narrow lumen, frequently arboriform branched, flexuous, interwoven, 1.5–2.5 µm in diam.

Tubes. Generative hyphae infrequent, hyaline, thin-walled, more or less flexuous, 2–2.5 µm in diam.; skeletal hyphae dominant, hyaline, thick-walled with a medium lumen, frequently arboriform branched, flexuous, interwoven, 1.5–2.5 µm in diam. Hymenial cystidia absent; cystidioles present, ventricose to fusiform, hyaline, thin-walled, 14–16 × 5–5.5 µm. Basidia barrel-shaped, with

Figure 4. Basidiomata of *Perenniporia rosicola* (Holotype, Y.C. Dai 22563). Scale bar: 1 cm.





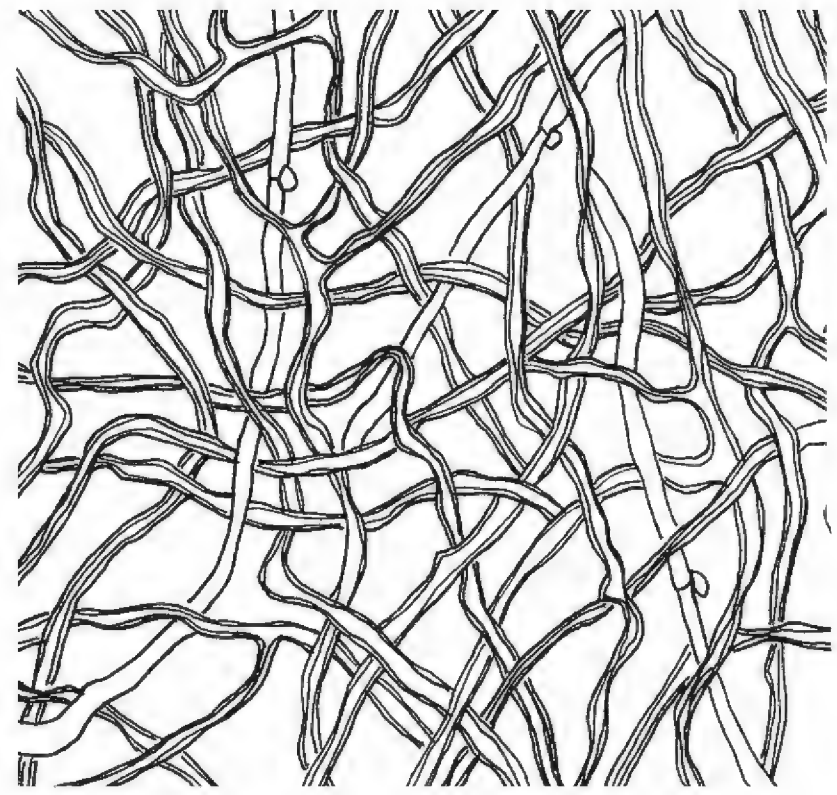


Figure 5. Microscopic structures of *Perenniporia rosicola* (Holotype, Y.C. Dai 22563) **a** basidiospores **b** basidia and basidioles **c** cystidioles **d** dendrohyphidia **e** hyphae from subiculum **f** hyphae from trama.

four sterigmata and a basal clamp connection, 16–20 × 7–8 μm; basidioles in shape similar to basidia, but smaller. Irregular crystals present amongst hymenia. Dendrohyphidia present.

Spores. Basidiospores broadly ellipsoid to subglobose, hyaline, thick-walled, smooth, sometimes with a medium guttule, dextrinoid, weakly CB+, 5–5.8(–6) × 4–5.2(–5.3) μm, L = 5.39 μm, W = 4.74 μm, Q = 1.14 (n = 30/1).

Type of rot. White rot.

Notes. *Perenniporia rosicola* is characterised by annual and resupinate basidiomata with a white pore surface when fresh, round to sometimes elongated pores of 5–7 per mm, frequently arboriform branched and narrow skeletal hyphae, the presence of dendrohyphidia, broadly ellipsoid to subglobose, thick-walled basidiospores measuring 5–5.8 × 4–5.2 µm and growth on Rosaceae in southwest China.

Combinations

In our phylogenetic analyses, *Crassisporus minutus* and *C. mollissimus* form two independent lineages nested in *Crassisporus* (Fig. 1) and their characteristics fit the definition of *Crassisporus*. So, we propose the following combinations:

***Crassisporus minutus* (Y.C. Dai & X.S. Zhou) Y.C. Dai, Yuan Yuan & Chao G. Wang, comb. nov.**
MycoBank No: 851530

Basionym. *Megasporoporia minuta* Y.C. Dai & X.S. Zhou, in Zhou & Dai, Mycological Progress 7(4): 254 (2008).

***Crassisporus mollissimus* (B.K. Cui & C.L. Zhao) Y.C. Dai, Yuan Yuan & Chao G. Wang, comb. nov.**
MycoBank No: 851531

Basionym. *Abundisporus mollissimus* B.K. Cui & C.L. Zhao, in Zhao, Chen, Song & Cui, Mycological Progress 14(38): 5 (2015).

Discussion

The genus *Perenniporia* s.s. clade includes four species, viz. *P. hainaniana*, *P. medulla-panis*, *P. prunicola* and *P. substraminea* and these species have the perennial and resupinate basidiomata with a cream, clay pink, buff yellow, pinkish-buff to fawn pore surface, a dimitic to trimitic hyphal system with amyloid or dextrinoid skeletal hyphae, ellipsoid, broadly ellipsoid to subglobose and thick-walled basidiospores (Table 2).

Perenniporia prunicola is similar to *P. medulla-panis* by perennial and resupinate basidiomata with a clay pink to buff yellow pore surface, round to slightly elongated pores of 4–6 per mm, a trimitic hyphal system and ovoid to broadly ellipsoid basidiospores. In addition, both species are phylogenetically related, but the latter lacks cystidia and usually has truncate basidiospores (Ryvarden and Gilbertson 1994). *Perenniporia puerensis* C.L. Zhao has annual and thin basidiomata, thin dissepiments, thick-walled skeletal hyphal encrusted with pale yellow crystals, the absence of hymenial cystidia and relatively smaller basidiospores (4.3–5.5 × 3.7–4.7 µm vs. 4.8–6.2 × 3.6–4.5 µm; Q = 1.14–1.21 (n = 120/4) vs. Q = 1.29–1.37 (n = 90/3), Liu et al. (2017)), which differ from *P. prunicola*.

Perenniporia rosicola is morphologically similar and phylogenetically related to *Perenniporia* cf. *dendrohyphidia* (Fig. 1). We studied the type of *P. dendrohyphidia*

(Rammeloo 6286) and they all have annual and resupinate basidiomata, the presence of dendrohyphidia and broadly ellipsoid to subglobose and thick-walled basidiospores. However, *P. dendrohyphidia* has thick and entire dissepiments, round pores of 4–6 per mm, sometimes apically truncate and relatively larger basidiospores (5.5–7 × 4.5–6 µm vs. 5–5.8 × 4–5.2 µm) and it occurs in Burundi, central Africa. Unfortunately, we did not obtain sequences from the type specimen of *P. dendrohyphidia*. We also studied the specimen of labelled Zhou 273 collected in China and it has thin and entire dissepiments, round to slightly elongated pores of 6–8 per mm, branched skeletal hyphae measuring 1.5–3.2 µm in diam., broadly ellipsoid to subglobose basidiospores measuring 5–6 × 4–5 µm. These characteristics are somewhat similar to *P. dendrohyphidia*. Thus, for the time being, we treat the specimen Zhou 273 as *Perenniporia* cf. *dendrohyphidia*. In addition, there are 20 base pairs differences between *Perenniporia* cf. *dendrohyphidia* and *P. rosicola*, which amounts to > 3% nucleotide differences in the ITS regions. *Perenniporia subdendrohyphidia* Decock was originally described by Decock from Cameroon, central Africa. However, it has smaller, oblong to oblong-ellipsoid and non-dextrinoid basidiospores (4–4.8 × 2.2–3.3 µm vs. 5–5.8 × 4–5.2, Decock (2001)). *Perenniporia sinuosa* Ryvarden was originally described from Amazonas, Brazil (Ryvarden 1987) and it differs from *P. rosicola* by larger pores (2–3 per mm vs. 5–7 per mm) and smaller truncate basidiospores (4–5 × 3–4 µm vs. 5–5.8 × 4–5.2 µm, Ryvarden (1987)). *Perenniporia adnata* Corner, *P. albocinnamomea* Corner, *P. ferruginea* Corner and *P. penangiana* Corner were all originally described from Southeast Asia and lack dendrohyphidia. In addition, the former three species above differ from *P. rosicola* by smaller basidiospores (4–4.5 × 3.5 µm in *P. adnate*; 3.7–4.7 × 2.5–3 µm in *P. albocinnamomea*; 3.5–4.5 × 3–3.5 µm in *P. ferruginea* vs. 5–5.8 × 4–5.2 µm, Corner (1989)). *Perenniporia penangiana* has pileate basidiomata with a stipe, which is different from *P. rosicola* (Corner 1989).

All species in the *Perenniporia* s.s. clade have perennial basidiomata with a cream, clay pink, buff yellow, pinkish-buff to fawn pore surface, a dimitic to trimitic hyphal system, sometimes the presence of dendrohyphidia and truncate basidiospores. *Perenniporia* cf. *dendrohyphidia* and *P. rosicola* both have annual basidiomata with a white to cream pore surface, a dimitic hyphal system, the presence of dendrohyphidia and broadly ellipsoid to globose basidiospores without truncation. All in all, some morphological characteristics of above taxa are overlapping, but the *Perenniporia* s.s. clade is unrelated to the *Perenniporia rosicola* clade in our phylogeny (Fig. 1).

Crassisporus minutus was originally described in *Megasporoporia* by Dai and Zhou from China and it is characterised by resupinate basidiomata with a cream to pale buff pore surface when fresh, distinct sterile margin, round pores of 4–6 per mm, a dimitic hyphal system; thick-walled to subsolid skeletal hyphae, cylindrical to oblong-ellipsoid basidiospores measuring 7.7–9.7 × 3.6–4.9 µm (Zhou and Dai 2008). The type specimen of *M. minutus* Zhou 120 grouped with other samples Dai 22571 and Cui 6595 nested in *Crassisporus* in our phylogenetic analysis (Fig. 1). However, we studied the sample Dai 22571 and it has slightly thick-walled basidiospores. Thus, the new combination *Crassisporus minutus* is proposed.

Crassisporus mollissimus was originally described in *Abundisporus* by Cui and Zhao from China and it is characterised by perennial, effused-reflexed to pileate basidiomata with a concentrically zonate pileal surface, a buff to

Table 2. The list of accepted species related to new taxa in this study.

Species	Type locality	Basidiomata	Upper surface	Colour of poroid surface	Dendrohyphidia	Basidiospores shape	Basidiospores size (µm)	References
Crassisporus imbricatus	China: Hainan	Annual, effused-reflexed to pileate	Yellowish-brown	Buff when fresh, pale greyish-brown when dry	–	Oblong ellipsoid	10–14 × 4.5–6.2	Ji et al. (2019)
C. leucoporus	Australia: Queensland	Annual, effused-reflexed to pileate	Yellowish-brown to umber-brown	White when fresh; cream, clay buff to pale yellowish-brown when dry	–	Oblong ellipsoid	8.4–11.2 × 4.2–5.4	Ji et al. (2019)
C. macroporus	China: Guangxi	Annual, effused-reflexed to pileate	Buff to yellowish-brown when fresh, yellowish brown when dry	Cream, buff to cinnamon buff when fresh; buff, pale yellowish-brown to yellowish-brown when dry	–	Oblong ellipsoid	9.5–13.2 × 4–6.2	Ji et al. (2019)
C. microsporus	China: Yunnan	Annual, pileate	Pale yellowish-brown to yellowish-brown	Cream, buff to cinnamon buff when fresh; buff, pale yellowish-brown to yellowish-brown when dry	–	Broadly ellipsoid	4–5 × 3–3.7	Ji et al. (2019)
C. minutus	China: Guangxi	Annual to biennial, resupinate	–	Cream to pale buff when fresh; pale greyish when dry	–	Cylindrical to oblong ellipsoid	7.7–9.7 × 3.6–4.9	Zhou and Dai (2008)
C. mollissimus	China: Hainan	Perennial, effused-reflexed to pileate	Yellow brown to umber-brown	Buff to buff-yellow when fresh, buff-yellow when dry	–	Ellipsoid	4–4.5 × 3–3.5	Zhao et al. (2015)
Perenniporia adnata	Singapore	Perennial, resupinate	–	Ochraceous buff to pinkish ochraceous	–	Broadly ellipsoid to subglobose	4–4.5 × 3.5	Corner (1989)
P. albocinnamomea	Malaysia	Annual, effused-reflexed	Pallid buff to brownish	Light cinnamon buff	–	Ellipsoid	3.7–4.7 × 2.5–3	Corner (1989)
P. dendrohyphidia	Burundi	Annual, resupinate	–	Wood-coloured to pale isabelline	+	Broadly ellipsoid to subglobose, sometimes truncate	5.5–7 × 4.5–6	Ryvarden (1988a), this study
P. eugeissonae	Malaysia	Annual, resupinate	–	White when fresh, cream to pale straw-coloured when dry	+	Ellipsoid	5–6 × 4–5	Du et al. (2020)
P. ferruginea	Brunei	Perennial, effused-reflexed	Ferruginous brown to fuscous blackish	Pallid wood white to pale brown	–	Ellipsoid, subtriangular to subglobose	3.5–4.5 × 3–3.5	Corner (1989)
P. hainaniana	China: Hainan	Perennial, resupinate	–	Cream when fresh, cream-buff when dry	+	Broadly ellipsoid, truncate	4–4.5 × 3–4	Zhao and Cui (2013a)
P. luteola	China: Henan	Annual, resupinate	–	Cream to buff when fresh, buff to yellowish-buff when dry	–	Ellipsoid, truncate	6.1–7 × 5–5.7	Zhao and Cui (2013b)

Species	Type locality	Basidiomata	Upper surface	Colour of poroid surface	Dendrohyphidia	Basidiospores shape	Basidiospores size (µm)	References
P. medulla-panis	Australia	Annual to perennial, resupinate	–	White when fresh; white, cream, pale corky when dry; greyish-orange when bruised	–	Ellipsoid, broadly ovoid to subglobose, truncate	4.7–5.8 × 3.5–4.5	Decock and Stalpers (2006)
P. nonggangensis	China: Guangxi	Annual, resupinate to effused-reflexed	–	Cream to greyish-cream when fresh; pale yellow-orange, capucine buff to sudan brown when dry	–	Broadly ellipsoid to subglobose	3.1–4.4 × 2.7–3.6	Huang et al. (2017)
P. puerensis	China: Yunnan	Annual, resupinate	–	Cream to buff when fresh, yellow to ochraceous when dry	–	Ovoid to subglobose	4.3–5.5 × 3.7–4.7	Liu et al. (2017)
P. penangiana	Malaysia	Annual, pileate with a stipe	Pale ochraceous to brownish	Pale tan ochraceous	–	Broadly ellipsoid	5–6.5 × 4–5	Corner (1989)
P. prunicola	China: Yunnan	Perennial, resupinate	–	Clay pink when fresh; cream, buff yellow to fawn when dry	–	Ellipsoid to broadly ellipsoid	4.8–6.2 × 3.6–4.5	This study
P. pseudotephropora	Brazil	Perennial, effused-reflexed to pileate	Pinkish buff, grey to greyish -brown	Greyish to pale brown	+	Broadly ellipsoid to subglobose, truncate	4.9–5.2 × 4–4.8	Wang et al. (2020)
P. rosicola	China: Yunnan	Annual, resupinate	–	White when fresh; pale orange brown when bruised, eventually honey yellow to clay buff when dry	+	Broadly ellipsoid to subglobose	5–5.8 × 4–5.2	This study
P. sinuosa	Brazil	Annual, resupinate	–	Cream to ochraceous	–	Subglobose, truncate	4–5 × 3–4	Ryvarden (1987)
P. straminea	Philippines	Annual, resupinate	–	Straw-coloured when fresh; pale yellow brown with orange tints when dry	–	Ellipsoid	2.5–3 × 2	Ryvarden (1988b)
P. subdendrohyphidia	Cameroon	Annual to biennial, resupinate	–	White, yellowish to pale pinkish cork-coloured when bruised	+	Oblong, Oblong ellipsoid to ellipsoid, truncate	4–4.8 × 2.8–3.3	Decock (2001)
P. substraminea	China: Zhejiang	Perennial, resupinate	–	White to cream when fresh, cream to pinkish-buff when dry	+	Ellipsoid, truncate	3.1–3.8 × 2.4–3	Zhao et al. (2013a)
P. subtephropora	China: Guangdong	Perennial, resupinate	–	Cream when fresh; cream buff to greyish-buff when dry	–	Ellipsoid to broadly ellipsoid, truncate	4–5 × 3.5–4.5	Zhao and Cui (2013a)
P. tephropora	Suriname	Perennial, resupinate to rarely effused-reflexed	Dirty greyish to black	Clay buff, grey to milky coffee or pale umber	–	Broadly ellipsoid, truncate	4.5–6 × 3.5–4.5	Ryvarden (1972b)

Bold = new taxa. Abbreviations used: + = Present, – = Absent.

buff yellow pore surface when fresh, round pores of 7–8 per mm, ellipsoid and slightly thick-walled basidiospores measuring 4–4.5 × 3–3.5 µm (Zhao et al. 2015). In addition, *Crassisporus* and *Abundisporus* are phylogenetically unrelated (Fig. 1).

Additional information

Conflict of interest

The authors have declared that no competing interests exist.

Ethical statement

No ethical statement was reported.

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Author contributions

All authors designed the research and contributed to data analysis and interpretation, and prepared the samples and drafted the manuscript.

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Data availability

All of the data that support the findings of this study are available in the main text.

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